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Agricultural Research in New Hampshire

Annual Report of Director
of New Hampshire Agricultural
Experiment Station for the Year 1934

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Agricultural Research in New Hampshire

Annual Report of the Director of the New Hampshire Agricultural Experiment Station for the Year 1934

J. C. KENDALL, Director

With a considerable body of knowledge of agricultural problems behind us, each decade still develops new questions which press for solution. The past few years have been a time of trial for the farmers of the state. The economic situation seems to have national and international implications—a sort of universal wave length which reaches to the last farm.

The increased cost of grains, for example, has raised questions as to the possibility of raising more of our own feed stuffs. The influx of many new part-time and subsistence operators has resulted in specialized questions as to effective procedure for this new clientele. Meanwhile, new processes, new trends in the world at large are constantly reshaping the demand for our farm products.

It is most fortunate that we have been able to carry on economic investigations during the past ten years. These studies have helped greatly to throw light on the unwieldy questions of marketing and economic production. The increasing importance of engineering problems has also been evident, and the need for much more work in this field is clear.

The various fields of knowledge are becoming so specialized that there is more need than ever for a coöperative attack on many problems. We are finding it more and more advisable to get the combined viewpoints of specialists in different fields, and an increasing number of our research projects are now being prosecuted on a coöperative basis between different departments. There are similar opportunities between the Experiment Stations of the different states in this region. The northeastern Station directors have been coöperating in an attempt to coördinate research and to combine forces where feasible; and regional conferences of various specialists are proving of more and more importance.

We are happy to announce that during the past year our chemical technique has been perfected for the determination of plant nutrients in soils. It is now possible to learn more about state soil samples than ever before, and to give more definite recommendations as to fertilizer treatment and soil management. Requests for this service are already increasing rapidly and are threatening to swamp our available facilities.

The soil fertility studies of the last few years are already indicating important facts as to soil management, and we now expect, through the cooperation of the Bureau of Soils of the United States Department of Agriculture, to begin next spring the long needed reconnaissance soil survey of the state. With the facts from this survey, with our improved technique for

handling individual samples, and with our knowledge gained from the series of experimental plots, it would seem that very shortly the Experiment Station may at last acquire a real mastery of the difficult and varied soil problems of the state.

During the year the Experiment Station was asked by the Civil Works Administration to organize and conduct several special studies: of tax delinquencies, tax deeds, and tax transfers; rural housing; part-time farming; and rural electrification.

It was necessary in the beginning of the year to start projects that would not only employ groups of office workers, and other so-called white-collar workers but that would also be useful and justify the money being spent. In spite of the short space of time between the request and the actual employment of the workers, the projects were started soon after the requests, and important data and statistics have been compiled.

The past year has seen few changes in our staff. Following the resignation of J. M. Fuller, dairy husbandman, K. S. Morrow was appointed to this position on July 1, 1934. C. W. Harris resigned July 1 as Research Assistant in Agricultural Economics. His place was filled by Stanley Colby, who in turn resigned on December 15, to be followed by Arno Hangas. L. R. Bryant completed his graduate assistantship in Horticulture last June, and his place has now been taken by Miss Mary Tingley.

Improved facilities in the technique of measuring basal metabolism have been added to our Nutrition Laboratory through the coöperation of the Nutrition Laboratory of the Carnegie Institution of Washington. Among other important equipment added during the year has been a Mojonnier milk tester which will make possible speedy and accurate testing of dairy products for both fat and total solids, a new colorimeter for our chemical laboratory, and a steam drier for handling hay samples in the agronomy laboratory.

The outbreak in March, 1934, of infectious laryngotracheitis on several poultry farms in the state made drastic action necessary at once in our poultry disease research. Efficient handling of the vaccine essential for preventing further spread of this disease necessitated a separate building on the University Poultry Farm, this building to be used for experimental work in the disease as well as to produce the vaccine at small cost to the poultrymen.

A new insectary, long needed by our Entomology Department, was erected last spring near the University Greenhouses.

As in other recent years, the Department of Entomology has had the benefit of an augmented technical staff through assistance provided by the treasury of the Crop Protection Institute. A part of the time of W. A. Westgate has thus been made possible in the important work relating to the physical-chemical constitution of spray materials and their performance. W. C. Baker has been enabled to continue ovicidal studies. The department's research program has been materially advanced by this arrangement.

The following is a brief review of significant findings in our various projects during the past year:

Effect of Potassium Deficiency

Plants suffering from extreme potassium deficiency are so stunted and abnormal that a comparison of them with normal may be misleading. This study was an attempt to find what differences in composition might occur

in tomato plants as soon as potassium deficiency could be recognized. The deficient plants were found lower in ash in per cent dry weight and in potassium, and higher in calcium, magnesium and phosphorus. They were also found high in solid, reducing sugars and insoluble nitrogen in per cent fresh weight and reducing sugars in per cent dry weight. The determinations gave no evidence of deranged nitrogen metabolism at this early stage of potassium deficiency. Results of this study have been published in Technical Bulletin 59. (*T. G. Phillips, T. O. Smith and R. B. Dearborn—Adams Fund.*)

Efficiency Studies in Dairy Farming

Twenty-five dairy farms in the Colebrook area have been mapped and possible crop improvements have been planned for five of these. A double rotation seems to work out to the best advantage. The best tillage land under this program is set aside for a three-year rotation of potatoes, oats, and clover. The remaining tillage, preferably in the nearby fields, is operated with a longer rotation for roughage. On these fields lime can be applied without disadvantage to a potato crop, and a five-year rotation of corn, and oats, and three years of hay is recommended.

Detailed chore records have been taken on twenty farms. It was found that one man spent 472 minutes daily caring for 34 cows, 15 heifers, 7 calves, and one bull—the equivalent of 74 animal units, and an average of 10.2 minutes per animal unit. (*H. C. Woodworth, C. W. Harris, S. Colby, and A. Hangas—Purnell Fund.*)

Dairy Herd Replacements in Southern New Hampshire

The majority of farmers in southern New Hampshire raise all or a part of their replacements, according to a survey of 201 farms for the year ending May 31, 1933. Only six of these farmers were purchasing all of their replacements compared with 45 raising young stock for income in addition to maintaining their herds.

The average feed costs of raising a heifer to age of freshening, exclusive of pasture costs, was $67. This represents about two-thirds of the total costs. Hay amounted to 54 per cent of the feed costs. Farmers admitted that they could buy cows cheaper than they could raise them, but felt that by raising them, the maintenance expense was less noticeable, they knew what they were getting, and disease was less likely. They estimated that over a period of years 6 cows out of every 10 purchased proved satisfactory compared with 7.2 out of every 10 heifers raised. The average price paid for cows was $77, $71 for grades, and $95 for purebreds.

There were 60 heifers for each 100 cows on May 1, 1933. The survey shows that this number was adequate for maintaining the herds. There were approximately one-half as many cows purchased during the year as there were heifers freshening for the first time. The average age of heifers at first freshening was 30.3 months.

There were fewer heifers under one year old at the end of the year than at the beginning. However, 66 farmers stated that they were raising more heifers in recent years than they had previously; only 11 farmers were raising fewer heifers. Others had made no definite change.

Farmers estimated the total carrying capacity of their pastures to be 3,296 cows or their equivalent in a normal season. This was 94 per cent of

the cows owned, exclusive of young stock, most of which were pastured off the farm. The value of pasture supplements was $276 per farm or $13.33 per cattle unit owned. There was no apparent tendency for farmers who were short of good pasture to raise fewer heifers than farmers with more adequate pasture. (*H. C. Grinnell—Purnell Fund.*)

Land Utilization in Grafton County

The belief that submarginal farms in the back towns of the state are being operated largely by old men is not borne out by a survey of 577 occupied places in the Grafton county area chosen for a study of land economic problems reports H. C. Woodworth of the University of New Hampshire Experiment Station. Slightly over 50 per cent of the operators were men under 50 years of age, and the survey indicates that many men in the prime of life are living on these farms which, in a great many cases, are not capable of efficient operation. Only 25 per cent of the operators were over 60 years of age, and the older men on the whole seemed to be doing as much farming as the younger men. Only in a few instances is the occupancy of the farms a deliberate step in old-age retirement.

It has been often assumed that in the process of agricultural abandonment the original owner persisted and that the operators of the farms are native to the region. From 388 records where figures as to years of occupancy are available, however, it was found that 21 per cent had lived on the farm for less than two years. The depression has brought many families into the region. Only 16 per cent had lived on the farm over 30 years.

The summary of the records indicates that farms in the area are operated mostly as self-sufficing units, and that from a commercial viewpoint agriculture is not important.

Farms Sorted by Gross Receipts from Sale of Agricultural Products

Receipts	*Group number*	*Number of farms*	*Per cent of farms*
0 — 50	I	261	45.2
51 — 100	II	59	10.2
101 — 500	III	136	23.6
501 — 1000	IV	56	9.7
Over 1000	V	65	11.3
		577	100.0

Forty-five per cent of the farms sell less than $50 worth of agricultural products per year, and only 21 per cent sell over $500 worth per year. On the other hand, the operators on most farms in the area are dependent upon outside work for most of their cash expenses.

In Group I out of a total of $334 gross receipts, $8 was from sale of agricultural products, $12 from sale of forest products, $236 from outside work and $78 was from gifts, pensions, and money taken from former savings. The returns from outside work make up about 70 per cent of the total receipts. Part of this was in the nature of unemployment relief work. All of the $78 from gifts, pensions, etc., would have come to the recipients no matter where they lived.

The data would indicate that occupants of farms in Groups I and II were almost wholly dependent on outside work for necessary cash expenses. Even operators in Groups IV and V, which do more farming, received $194 and $163 respectively from outside work. This outside work is very essential even to the maintenance of present standards of living.

That the farms are not now organized and equipped to sell products from the farm if there is a return to general prosperity is indicated by the extent of the physical plant for agricultural production.

In Group I, consisting of 45 per cent of the farms, the average situation indicates a great lack of opportunity to do more farming than merely growing some products for home consumption.

The average amount of tillage land per farm in this group was 15 acres. The yielding power of this small acreage has declined to the extent that only a very limited amount of livestock could be carried. At present the average number of livestock carried in Group I is: .9 cows, .4 heifers, .4 horses, and 10 hens. This is equivalent to 1.6 animal units. This is equivalent to one animal unit per 10 acres of tillage land, or about one-fifth that of average farms of the State and one-tenth that of the better farms of the State.

The present yielding power of the farms in Group I is very low, and because of the small amount of stock together with present practices of tillage the trend is toward lower yields. The yields of hay are so low on many farms that it no longer pays to harvest it.

The situation as described for Group I is more or less true also for the farms in Groups II and III. While more livestock is maintained the situation is not very optimistic as far as trend of yields is concerned.

The yields and carrying capacity of these farms cannot be brought back without considerable investment in time and money. Frequently one farmer may start the process of the rejuvenation of a single farm by purchasing standing hay on nearby abandoned farms and carrying considerable livestock in this way. With more livestock and an aggressive cropping program the yields can be brought back in the course of time. This method, however, will work only for the occasional farm and cannot be employed to bring back all farms.

There is nothing indicated in the outlook for demand or land requirement that would justify the expense necessary in rebuilding the fertility and yielding power of the farms.

From the viewpoint of commercial agriculture these farms, on account of low yielding power, location, or small fields and rocks, can be ignored. A few farms in Groups IV and V can be considered of some commercial importance and those best located would probably continue indefinitely as commercial farms. (*H. C. Woodworth—Purnell Fund.*)

Study of Delinquent Taxes, Tax Sales, and Transfers

A Civil Works Project concerning rural tax delinquencies, tax sales, and farm real estate transfers in 92 per cent of the towns in New Hampshire was reviewed. This study revealed a lack of uniformity among local tax units relative to the levying, recording, and collecting of property taxes. In many cases practices do not comply with the statutes or with sound tax policies. Irregularities in local practices, more particularly those concerned

with the advertisement and sale of delinquent properties, affect the comparableness of the data assembled for this project.

The majority of properties advertised or sold were the same year after year. The owners redeemed them, only to repeat the same routine by failing to pay the subsequent levy before being advertised again. The real index of distress, therefore, lies, not so much in the amount of delinquencies as in the number of new names on the lists. The latter represent increased delinquencies.

The total value of rural real estate tax delinquency, as advertised for sale and reported to the County Register of Deeds, in all counties except Merrimack and Sullivan, increased from $81,596 in 1928 to $176,483 in 1931, the peak year, mounting at the rate of nearly $32,000 per year. This represents an increase of 116 per cent in the amount of delinquent taxes, 92 per cent in the number of properties and 120 per cent in acreage. The greatest increase for any one year was for the 1931 levy when the amount of delinquent taxes increased 61 per cent over 1930. There was a decline in 1932 from 1931, due more to a lower average tax rate than to fewer properties. Delinquency was apparently most severe in Coos, Grafton, Rockingham, and Belknap Counties. Had the entire State been surveyed on the same basis, tax advertisements for the 1932 levy would have approximated 260,000 acres of rural lands and involved $180,000 of tax money.

More than three-fourths of the advertised properties were classed as farm land with buildings and eight per cent as forest lands. The former class comprised 79 per cent of the delinquent land area and 89 per cent of the total assessed value of all delinquent properties.

Sixty-seven per cent of the advertisements for the 1931 levy went to sale in 1932 as compared with about 56 per cent for other years, further distinguishing the 1931 levy as being especially burdensome. The value of tax sales for all counties in 1932 was 232 per cent of that in 1929. This indicates that tax sales were increasing proportionately faster than tax advertisements and thus a smaller percentage of notices were being discharged before sale. Tax sales in the State as a whole, no doubt, exceeded 172,000 acres of rural lands and represented nearly $135,000 in value in 1932.

In 53 towns in 1933 there was a total of 483 farm real estate transfers involving 32,821 acres of land compared with 563 transfers or 34,232 acres in 1929. However, only 89 per cent of the 1933 transfers were voluntary compared with 99 per cent of those of 1929. (*H. C. Grinnell—Purnell Fund in Co-operation with F.E.R.A.*)

Spray Management Studies

Spray records kept by 50 apple growers seem to indicate that it is good insurance to apply as many sprays as will warrant a good clean crop of fruit. One of the best crops in the state and the cleanest crop ever produced in this particular orchard showed this past year a total cost of $268.79 for spray and dust material to protect the crop of 8,250 bushels, or an average cost of 3.26 cents per bushel. The most expensive spray application came to only .6 of a cent per bushel.

The question of the number of cover sprays is frequently raised.

In considering any one spray in most orchards the cost of materials represents the greater part of the actual out-of-pocket expense. The spray

outfit, the power and the men are usually available. The depreciation of the spray machinery is more a question of age and becoming obsolete than of excessive wear. If horses are used they are on the farm and often would be standing in the barn if not used on the particular spray. An extra man may need to be employed for the short time. Some gasoline, oil, and other expense will be required if tractor power is used.

So in making the decision as to the application of a certain cover spray, the cost of material, including gasoline and oil, are the determining factors on the expense side.

However, if based on normal rates of wages for all labor, including that of the operator and a proportional cost for spray machinery and power, the cost of applying each spray would about equal the cost of materials. Thus the total cost would be about $.012 for each application. But since all the equipment must be available for the other sprays when deciding about any one spray, only the additional cash costs need to be considered on most orchards. There is usually no competing use of men or power at these spray periods. (*E. S. Rasmussen, H. C. Woodworth, and G. F. Potter—Purnell Fund.*)

Egg Auction Sales

In coöperation with the recently formed New Hampshire Egg Auction at Derry, data are being obtained as to producer's name and number, weight, size and grade, selling price, buyer and order of sale of every case of eggs sold. Also an individual record of every producer is being tabulated which gives us percentages of eggs falling into specials and extras, the classification of all eggs not falling within those grades and the gross returns, charges, and net returns for all eggs sold.

Records for the first five months showed average monthly premiums of 2.2 cents to 5.1 cents for special large brown eggs over top Boston wholesale quotations. (*L. A. Dougherty—Purnell Fund.*)

Soil Fertility Experiments

These studies, as in previous years, involve hay and legumes on neglected hay lands, Whenal Farm, Greenland; dairy farm rotation on neglected hay lands at the Lane Farm, Pittsfield; potatoes in a three-year rotation at the J. R. Jackson Farm near Colebrook; legumes in the Connecticut Valley at the Livingston Farm, Claremont; and scattered experiments on top-dressing old pastures. The plot work is accompanied by chemical studies.

Legumes on Neglected Haylands. The legume studies this year indicated no significant increase for additional lime applied in 1933. For the present, two tons of limestone in 1926 is proving slightly superior to one ton in 1933. All of the plots which had potash revealed significant differences in the first cutting of alfalfa, and also with one exception in the second cutting. Nitrogen gave a significant increase in the first cutting only. Phosphorus appears to have stimulated the yield in the first cutting.

When this experiment was begun, part of the alfalfa plots received two tons and part four tons of ground limestone per acre. During the fifth and sixth years, the acidity of the soils of these plots increased considerably. In the fall of 1932 the pH values of these plots were 5.38 and 5.81 respectively. In the fall of 1932 these plots were plowed. Soil samples taken in the spring

of 1934 had pH values of 5.70 and 6.05 respectively. It is interesting to note that, while plowing has usually resulted in decidedly decreased pH values for soils, in this case, without the addition of lime, the pH values were increased. It is thought that the plowing resulted in the thorough mixing of the residues of the six year old applications of limestone with the soil, resulting in its renewed activity in neutralizing acids.

The highest pH value obtained by the application of ground limestone at the rate of eight tons per acre was 6.5. Mixed samples taken to the depth of seven inches gave this result. The ground limestone was applied in the spring of 1931 and harrowed in well. After two years the neutralizing effect of the heavy application of limestone is hardly evident below the six-inch level, and with four tons or less no appreciable effect is noticed below the four-inch level.

An attempt to reconcile the need for lime on the part of legumes in the rotation with scab-free potato production compared applications of aluminum sulphate and sulphur at the rate of 900 pounds and 300 pounds each per acre. In these attempts to acidulate soil prior to potato planting, the heavier application of aluminum sulphate proved the most effective of the treatments, and the percentage of scab was considerably reduced over the no-treatment plots. In no case, however, were the potatoes free from scab. The limed plots in the rotation show increased yields of about 70 bushels per acre over the no-lime plots. This is doubtless due to the fact that the soy beans on these plots grew much better yields following the lime applications, and the beans were used as green manure.

Magnesium limestone has been giving such a significant increase over other plots in the soy bean experiments at Greenland that it seems evident that this element is a limiting factor for the crop on this soil.

Dairy Farm Rotation at Pittsfield. The omission of phosphorus and doubling the phosphorus content caused little difference in yield. This was in direct contrast to similar experiments in northern Coös County. Changes in the nitrogen application also did not prove significant. The omission of potash, however, caused a serious decrease in yield, a difference almost as great as omitting the fertilizer altogether. Magnesium does not appear to be a limiting factor on this soil. In the oats plots, the only treatments which caused a wide variation was the omission of phosphorus and the omission of fertilizer altogether. In both these series of plots the yields were depressed.

Potato Rotation. In the potato rotation at Colebrook, extra phosphorus as well as extra potash has given consistent increases during the past six years. Last year, therefore, high phosphorus and high potash were combined. This gave a significant increase over check plots. In the potato plots, an application of sulphur at planting time served to bring a scab count on the four-ton lime series considerably lower than in the two-ton series. Smaller lime applications are being tried on other plots to see how much lime can be used without scab difficulties and still encourage the growth of clover. The oats plots have apparently suffered considerably when an element is omitted in the fertilizer, or when a shortage of plant food has been applied, but they respond to the lime which had previously been applied in the rotation.

Pasture Experiments. In the pasture top-dressing experiments at Claremont, of the nitrogen carriers tried, Cal-Nitro seems to have given the best

results, followed by nitrate of soda, calcium nitrate, sulphate of ammonia, and cyanamid, in the order named. Twenty-five pounds of nitrogen per acre returned considerably more than half as much dry matter and protein as 50 pounds per acre. Complete fertilizer gave significant increases in the yields.

In the pasture experiment at Greenland, on the other hand, there was little response from minerals other than nitrogen. Sulphate of ammonia gave the best response of the nitrogen carriers, with nitrate of soda second.

In pastures where Dutch Clover forms a part of the stand, there have been significant increases from applications of phosphoric acid and potash, while grass responds mainly to nitrogen. (*F. S. Prince, P. T. Blood, T. G. Phillips, and G. P. Percival—Purnell Fund.*)

Time of Cutting Hay

As in previous years, the experiments indicate that very good hay for feeding cows can be made from timothy if it is cut early. The cutting on June 10 showed a significant increase in pounds of protein per acre over later cuttings as did the second cutting on these plots also. In 1933 the heaviest total yield was recorded for the July 30 cutting. This is contrary to results from former yields when the heaviest cutting usually came July 10 or July 20. Whether this is due to the accumulative effect of harvesting later or to seasonal factors is not yet known. (*F. S. Prince and P. T. Blood —Purnell Fund.*)

Nutrition Studies with Dairy Cows

The study of the comparative nutritive value of different varieties of hay which has been carried on in connection with the physiological investigation on the nutrition of dairy cows was extended to alsike clover hay and red clover hay. The relative availability for dry cows of protein and of energy, (metabolizable energy), per 100 pounds, of the forages so far studied is as follows:

PER 100 POUNDS OF HAY

	Energy	Protein
	Metabolizable	Digestible
	Cals.	*Lbs.*
Alfalfa, 2nd cutting	97400	10.81
Timothy hay cut June 20	95600	6.42
Soybean hay	91400	4.69
Alsike clover hay	84500	4.39
Alfalfa, 1st cutting	80800	10.17
Timothy cut July 1	80800	3.19
Red clover hay	79100	9.44
Timothy cut Aug. 1	76400	1.69

Red clover hay, it will be observed, stands relatively low as a source of energy but as a source of digestible protein it ranks very close to alfalfa. Alsike clover hay is at the bottom of the list of legumes as a source of digestible protein although it contains somewhat more available energy than 1st cutting alfalfa or red clover.

Alfalfa and red clover hay stand in a class by themselves for protein content as they supply nearly twice as much of this food compound as any of the other legumes or the grass hays measured.

Soybean hay, as previously reported, stands very high in available energy but is only medium or below in digestible protein, and alsike clover is only medium or below in both.

Of outstanding interest is the fact that timothy hay when cut early and properly cured will make one of the more valuable roughages, while delay in haying until after July 30 reduces its value to the bottom of the list.

Nine experiments were carried out during the year in which the metabolism was measured on four cows off pasture. The results, which are largely of physiological significance, will be prepared for publication during the coming year, although it may be stated at this time that the metabolism of cows on pasture is on an extraordinary high level, indicating that good pasture is apparently the cheapest and most effective method of feeding. (*E. G. Ritzman and F. G. Benedict—Purnell Fund.*)

Metabolism of Livestock

Studies in the basal metabolism of sheep, goats, and the horse were carried on during the year. The results of the first two experiments are being prepared to be published in the very near future. The last was carried out with a very small adult pony. The object was to determine whether the extraordinary high basal metabolism found with the larger members of this species, such as the Percheron, was also characteristic of the smaller members. The study seemed to prove this to be true. (*E. G. Ritzman and F. G. Benedict—Adams Fund.*)

Sheep Breeding

Progress made thus far in the sheep breeding investigation makes it apparent that the development of a single trait, either nipples or twin production, might be accomplished in a relatively small number of generations provided selections could be made with entire disregard to other traits. In this particular research, however, the object is not only to establish two traits at the same time, but to transfer these traits from a coarse wooled sheep of inferior mutton conformation to one being superior in this respect. The problem thus becomes theoretically sixteen times as complex as though a single trait were involved.

In the matter of producing 4-nippled sheep bearing largely twins, progress has been made. A total of 85 lambs dropped this year include one set of triplets, 62 twins and 20 singles. The triplets include two 6-nippled, one five-nippled lambs, and the twins include two 6-nippled, one 5-nippled, thirty-six 4-nippled, eight 3-nippled, and fifteen 2-nippled lambs. That is, 76 per cent of the twins are multi-nippled.

This improvement in the establishment of multinipples and twin potential has been achieved without loss of other desirable qualities as is evidenced in competition with wool from all over the United States graded by the National Marketing Corporation. The report stated, ". . . , we graded your entire clip in our New York grading line, and we found the wool better, for style and condition, than the average of the line, which we considered very good style of farm-flock wools." (*E. G. Ritzman, A. D. Littlehale, and N. F. Colovos—Adams Fund.*)

Lime-sulphur Injury

Experiments were made during the year for the purpose of studying the conditions under which spray injury occurs, and the extent to which spraying with lime-sulphur solution interferes with the elaboration of dry matter.

It is not uncommon for the first formed leaves on the apple in orchards sprayed with lime-sulphur to turn yellow towards the end of June and fall. This chlorosis and premature fall is usually ascribed to lime-sulphur injury, but it would seem from observations made during the year, that this conclusion may need qualification. It has not so far been possible to produce a yellowing of the apple foliage at will, so that the other factors concerned have not been determined; but the evidence collected does not indicate that spraying during very hot weather is as injurious as currently believed. No injury has thus far been caused to the apple by spraying at temperatures ranging between 30 and 40°C in the shade.

Besides work with the apple, experiments have also been made with the bean and potato. In the experiments with the bean the object was to study the effect of strength of lime-sulphur used on spray injury and elaboration of dry matter. The dilutions of lime-sulphur solution used were 1-50, 1-100, and 1-200. Spray injury was produced at all the strengths used and was on the whole slightly less severe in the case of the more dilute solutions, though the differences were not great. The injury produced, measured in terms of dry matter formed, was, at all strengths used, quite immaterial. (*O. Butler—Adams Fund.*)

Effect of Weathering on Injury

Experiments have also been made with the bean for the purpose of studying the effect of weathering on injury, but no difference could be detected between plants placed outdoors at night or during rain, and those protected from dew and rain.

An experiment was made using the potato to study the effect of spraying with lime-sulphur solution 1-50 on plants grown at a mean temperature of 14.9°C and a mean temperature of 22°C. When the experiment was brought to a close the sprayed potatoes grown at 22°C could not be distinguished from the non-sprayed plants, while in the case of the potatoes grown at 14.9°C the lower leaves of the sprayed plants were chlorotic and obviously maturing faster than the non-sprayed. Spraying reduced the yield, the greater loss occurring in the plants grown at 14.9°C.

Studies were also made during the year on the changes induced in lime-sulphur solution by aluminum sulphate and ferrous sulphate. Both these substances reduce the active alkalinity and percentage of soluble sulphides present. We know that in many cases a reduction in active alkalinity will reduce spray injury, but in the case of lime-sulphur solution the reduction of spray injury accompanying the use of ferrous sulphate or aluminum sulphate would appear to be due primarily to the more or less complete destruction of the sulphides present. (*O. Butler—Adams Fund.*)

Dye Adsorption

The effect of temperature, mineral nutrition, and selection on hardiness and the extent to which the changes induced were measurable by the dye adsorption test was studied during the year, with the following results:

In the temperature tests cabbage and potato plants were used. It was

found that in the former an increase in hardiness is accompanied by an increase in dye adsorption and in the latter the reverse condition obtains.

One series of cabbage plants was grown at a temperature range of 10-20°C and another series of 20 plants at a temperature range of 20-30°. Sixty-two days after the experiment was set up both series of plants were placed at a temperature of -5°C for 24 hours. The cabbage plants grown at 10-20° showed a mortality of 30% five hours after chilling, 45% seven days after chilling, and 28.2% dye remaining in solution in samples taken immediately after chilling. The plants grown at 20-30° showed mortality of 40% five hours after chilling, 90% seven days after chilling, and 45.0% dye remaining in solution in samples taken immediately after chilling.

In the case of the potato two series of 25 plants each were grown at the same respective temperature range as the cabbage. After the plants had grown to a sufficient size they were placed at a temperature of -1.1°C for 20 hours. None of the potatoes grown at the lower temperature range were killed, but in the series grown at the higher range the mortality was 40 per cent. The dye adsorption test showed that the plants surviving the chilling, whether grown at the higher or lower temperature range, behaved in a similar manner, but that in the case of the non-resistant plants the series grown at the temperature range 20-30°C adsorbed more dye than the plants grown at 10-20°C.

In a study of the effect of selection on hardiness, four generations of Bryophyllum have been grown and chilled at a temperature -1.1°C. The effect of selection on the resistance of Bryophyllum to cold is readily shown by the fact that unselected stock showed a mortality of 85%. The first generation of a selection from hardy individuals showed a mortality of 27%; the second generation, 23%; and the third generation, 35%. It would appear from this that resistance to a temperature of -1.1°C can be materially increased by selection up to a certain point, but not beyond.

The Jerusalem artichoke is a much hardier plant than Bryophyllum and after preliminary trials a temperature of -4°C was selected as suitable for separating resistant from non-resistant plants. A number of Jerusalem artichokes were subjected to a temperature of -4°C for hours. The plants surviving this treatment were grown to maturity. The crop obtained was saved and the tubers planted in one series of pots, while tubers from unselected stock were planted in another series. After the plants had grown 90 days both series were exposed to -4°C for 15 hours, the results obtained being as follows: plants from selected hardy stock, 40% killed; plants from unselected stock, 73% killed.

A study in continuation of previous work was made on the effect of low and high phosphorus levels on hardiness and dye adsorption. Cabbages were used in the experiment and the plants were grown in sand cultures. Phosphorus was not found to materially affect dye adsorption or hardiness.

Fluorides have been reported as increasing the bound water in tobacco, but the addition of a fluoride to sand cultures did not increase the hardiness of cabbage and the dye adsorption test did not show an increase in bound water. (*S. Dunn—Adams Fund.*)

Bitter-Pit in Apples

The effect of hay mulch on the development of bitter-pit in apples was studied during the year. The hay was placed round the trees at the approximate rate of 400 pounds per tree during July, so that the tree would become adjusted to the change in environment brought about by the mulching when the next growing season opened.

The experiment on the effect of fertilizer on bitter-pit was brought to a close during the year. No direct effect was obtained from any fertilizer combination, either with or without the heavy application of lime. It was observed, however, that the per cent of bitter-pit present was affected by the yield; hence the fertilizer combinations most effective in increasing yield did indirectly reduce the incidence of bitter-pit. Good results were obtained from the use of a phosphatic manure alone, a nitrate alone, and a nitrate combined with a phosphatic or potassic manure was more active than a complete fertilizer.

Continuing work on the development of bitter-pit in storage, confirmation, in general, of results previously obtained has been established. It was found that the date of harvest has some bearing upon the development of bitter-pit in Baldwin apples. Apples harvested on October 7 showed a total of 76.1% and no internal symptoms; apples harvested on October 16 showed a total of 53.9% and 9.2% internal symptoms only; fruit harvested on October 23 showed a total of 43.9% and 16.0% internal symptoms only; and fruit harvested on October 30 gave no indication of bitter-pit. (*O. Butler—Purnell Fund.*)

Potato Disease Experiments

Mosaic potato plants grown at a mean temperature of 20°C outyielded the plants grown at a mean temperature of 15°C, results which confirm data previously obtained. It was also found, again confirming previous observations, that unmistakable symptoms of mosaic do not appear at any regular and set interval following the date of emergence. The earliest date of appearance of symptoms was two days after emergence, the latest 12 days. To date mosaic plants have shown no tendency to run out, either when grown continuously at a mean temperature of 20°C, or 15°C, or when after growing one season at one temperature they are removed the next season to the other.

Leaf-roll plants show a marked tendency to become less productive from year to year when grown continuously at a mean temperature of 20°C or 15°C. When, however, plants grown one year at either mean temperature are removed the next to the other, unproductiveness is increased, and especially so in plants moved from the higher to the lower temperature.

The behavior of the seed-piece of leaf-roll plants is affected by the temperature at which the plants are grown. In the case of plants grown at a mean temperature of 20°C seed piece decay is the rule. The results secured during and including all the series of plants grown were as follows: plants grown at 15°C showed seed-piece decay of 7.7 per cent; plants grown at 20°C showed seed-piece decay of 50 per cent.

The healthy plants grown have not shown, up to the present, any tendency to become less productive when grown continuously at either 20°C or 15°C, nor has removal from season to season from one mean temperature to the other caused any ill effect. (*O. Butler—Purnell Fund.*)

Apple Scab Experiments

In spraying experiments on McIntosh apples the use of a second cover spray gave substantially twice the scab control obtained with one cover. These results are in agreement with previous work. Two cover sprays are required for the control of scab on McIntosh. Experiments were made during the year with cal-mo-sul (calcium monosulphide) lime-sulphur solution 1-50 followed by flotation sulphur beginning with the calyx application. The scab infection on the check trees in the cal-mo-sul plot was light, and the control obtained with this fungicide was as satisfactory as that given by lime-sulphur solution; but it should be noted that previous experience with cal-mo-sul under conditions of heavy infestation has been extremely disappointing. The use of flotation sulphur in lieu of lime-sulphur solution 1-50 beginning with the calyx application gave substantially the same control as lime-sulphur solution 1-50 used throughout the season.

In some of the plots lead arsenate was used in the lime-sulphur solution when an arsenical was required; in others, calcium arsenate. No increase in foliage injury resulted from the use of calcium arsenate, nor was there any difference in the finish of the fruit.

In experiments with Baldwins the results confirm previous findings that the Baldwin is much less sensitive to scab than the McIntosh. One cover spray gave ample protection. The substitution of calcium arsenate for lead arsenate in lime-sulphur solution was not found to significantly increase foliage injury.

The ascospores were mature on April 24, but no discharge occurred in nature until May 10th. The delayed discharge was no doubt due to the scantiness of the rainfall. The first rain after April 24 occurred on May 4 (.02 in.) and the next on May 9th (0.37 in.). The pre-pink spray was applied May 5. The data so far secured indicate that irrespective of the length of the snow cover in winter, or the mean temperature of the winter, ascospores mature during the last ten days in April, and discharge occurs during the first wetting rain following maturity. (*O. Butler and S. Dunn, Hatch Fund.*)

Contact Insecticides

The results in two further phases of the studies in contact insecticides have been completed and published during the year as Technical Bulletin 58, entitled, "1. Methods of Expressing Toxicity. 2. Toxicity of Nicotine, Heptylic Acid and Caproic Acid to Mosquito Larvae *Culex pipiens* L."

Substantial progress was also made in an investigation of the performance of several familiar contact agents when applied to various leaf surfaces. Such performance has a definite relationship to toxicity against insects. While a contact insecticide is designed to kill an insect through contact with that insect's body, the ability of such an insecticide to spread over leaf surfaces may also play a prominent part, because spread on a leaf may mean that the insecticide is the more readily able to reach the insect. Furthermore, if a material spreads quickly and evenly over a leaf it may be safe, whereas if it collects in droplets it may be unsafe because the droplets on drying may subject the leaf to undue concentrations of the spray.

Several contact agents were included in these studies. Data were secured as to the performance of sodium oleate, saponin, triethanclamine oleate, potassium cocoanut oil soap, Gardinol, calcium caseinate, and monoamyla-

mine oleate. Nine species of plant leaves and seven of plant stems were used as surfaces. Paraffin-coated glass slides and two species of insects were used for comparison. Surface tensions were measured.

The results of the investigation are now being prepared for publication.

A further line of investigation now begun is concerned with the influence of temperature, moisture, and sunlight on the contact performance of a given spray material. In addition, preliminary studies indicate that at least some materials exhibit different contact qualities when delivered from a spray nozzle, as compared with their performance when applied as a single droplet to the surface of a given solid. Whether this may be due to momentum of minute particles of liquid, or to molecular contamination of the surface adjacent to a droplet, or to some other factor, remains to be seen. Certainly there is evidence, also, that the character of the leaf surface may vary in unsuspected degree as temperature rises. (*W. C. O'Kane, J. G. Conklin, E. C. Glover, and W. A. Westgate—Purnell Fund.*)

Ovicides

Two phases of the department's study of ovicidal performance were concluded and published as Technical Bulletin 60, "1. Technique for Tracing Penetration of Petroleum Oil in Insect Eggs. 2. Some Determinations of Oil Penetration into Insect Eggs."

Following the development of new technique for tracing the penetration of petroleum oils into insect eggs by means of stains, determinations of actual penetration of oils into insect eggs were carried through successfully. It was definitely proved that with the insects studied and with the oil used, extensive penetration does take place.

In spite of an assumption to the contrary it was also found that fixing fluids penetrate the eggs of insects. Penetration has been definitely proved, and an attempt will be made to record it by photomicrographs. (*W. C. O'Kane—Adams Fund.*)

Apple Maggots Succumb to Oil

Work on apple maggot control was continued at Wilton and at Durham.

At Wilton a large cheesecloth cage was erected over the accumulated pile of drops from last season, the drops having first been treated with old crankcase oil. Only two apple maggot flies were recovered from this cage, indicating that the oil treatment of drops was entirely successful in preventing emergence. (*W. C. O'Kane and J. G. Conklin—Hatch Fund.*)

Experiments with White Pine Fence Posts

Effective and inexpensive treatment of white pine posts can be obtained by the open tank method of creosoting according to studies over the five-year period 1929-1934.

Untreated posts used during that period showed 75% decay; brush treated posts were 11% decayed; open tank created posts, pressure treated posts, and ZMA (a zinc arsenic compound) treated posts all proved sound. The decay in the first two groups varied from ½ inch depth radial break down to complete decay.

The study suggests that there is a more profitable way to use straight pine wood thinnings than for fire wood. (K. W. *Woodward—Hatch Fund.*)

Phosphorus Shows Slight Influence on Bud Formation

In the Woodman Orchard at Durham, a series of field plots has been used during the past six years in an effort to determine whether the incorporation of a large amount of phosphorus deeply in the soil will have a measurable effect upon blossom formation. The results at the close of the 1933 season seemed to indicate a slight but scarcely significant increase in the blossom formation on trees receiving the phosphorus. The results in 1934 are inconclusive owing to the injury to the trees during the winter of 1933-34. It is likely that the plots will have to be discontinued. (*G. F. Potter—Adams Fund.*)

Apple Pollination Studies

Tests were begun in 1934 on pollination requirements of the Melba, and Milton, which are hybrid seedlings of the McIntosh. Tests were continued on the pollination requirements of Cortland and McIntosh. None of these varieties were found to produce satisfactory crops with self-pollination, although Melba seems somewhat more self-fruitful than the others. Using pollen of the Starking (a red sport of Delicious) as a control, it was found that cross-pollination of these varieties with pollen of the Early McIntosh, the McIntosh, Milton, Melba, Cortland, and Macoun produced good sets of fruit except in the case of Cortland pollinated by Early McIntosh. The Starking was used as a control because over a series of years an exceptionally good and regular set had been obtained with Delicious or its sports.

When pollen of several triploid varieties, (those having an extra set of chromosomes), namely Baldwin, Gravenstein, King, Rhode Island Greening, Roxbury, and Staymared (a red sport of Stayman) was used, a reduced set of fruit was obtained. This was accompanied by a low seed count, and in most cases, also by a large percentage of misshapen fruit. In all cases of unsatisfactory pollination there was an accompanying low seed count and a high number of empty seed cavities.

These results are of immediate practical importance in that they demonstrate that triploid apple varieties cannot be depended upon as pollinators of the varieties named. Where they have been set with this purpose in view, other varieties should be grafted in to take their place. On the other hand, the McIntosh and its hybrids seem to be perfectly inter-fertile, with the possible exception of Early McIntosh and Cortland. (*L. P. Latimer—Purnell Fund.*)

Changes in Apples During Storage

In common storage Baldwin apples were found to soften in about thirty days to almost full-ripe; they reached prime flavor by December 12th. Thereafter they remained about constant in firmness until the first of May, but continued to lose their dessert quality. Such apples are good only for the early winter market. Baldwins at 32°F. softened at a more uniform rate throughout the storage season and reached fine quality about the middle of March. At 30°F. the rate of softening was not appreciably different, but the flavor developed much more slowly and at its best was inferior to that of the other two lots.

As in previous years, it was found that fruit grown in different orchards differed significantly in firmness, acidity and flavor. This confirms opinions frequently held by practical fruit growers that apples from certain orchards

keep better than others. The two orchards under test are about two miles apart. Soil factors may be responsible, or it is possible that, owing to differences in topography, there is sufficient difference in the temperatures under which the apples grow in these two locations to account for the differences found in storage quality.

In testing lots from three different fertilizer plots in the Renovated Orchard at the Horticultural Farm, it was found this year that fruit from a cultivated plot which is fertilized with five pounds of nitrate of soda per tree was firmest, lowest in acidity, and superior in flavor during most of the season. Fruit from a plot under sod culture with a complete fertilizer containing ten pounds sodium nitrate per tree was softest, had the greenest ground color, and highest acidity. Fruit from the third plot under sod culture with ten pounds of nitrate of soda per tree was intermediate in all respects. Results similar to these have been obtained in one previous season, but in two other years there has been no significant difference in the quality of the fruit from the three different plots. It seems impossible to draw definite conclusions as to whether this difference is actually due to the fertilizer and as to why it appears in certain seasons and not in others. In addition to the differences noted above which had been observed previously, it was found this season that by July 17 the trouble known as brown core occurred in 43% of the apples from the sod nitrate plot, 63% of those from the cultivated nitrate plot, and 80% of those from the sod complete plot.

Cortland apples picked at about the time of McIntosh harvest were found when removed from storage to be very subject to scald, even though wrapped in oil paper. Fruit picked about three weeks later showed none of this trouble, and at the same time remained perfectly free from internal breakdown of any sort until July 17. If this finding is corroborated by further study, it will be of the greatest significance with regard to the commercial development of the Cortland variety. Another very important finding with respect to the Cortland is that it was judged to be prime in flavor over a longer period than either the McIntosh or the Baldwin. Although it retains its color and its attractive appearance well in storage, the McIntosh becomes progressively more tasteless after February, and many believe that it is unwise to extend its marketing season into March and April as is now the practice. Almost all of a large number of persons who in these tests were asked to sample Cortland and McIntosh after the end of January judged Cortland to be the better. It was also pointed out that the Cortland apple does not oxidize rapidly on paring, and for this reason is especially well adapted for salad purposes.

McIntosh, as in previous years, when stored at 32°F. immediately after picking kept firmer, higher in acidity, and greener in ground color than if a delay occurred after picking and before storing. However, on the average, a slight delay tended to improve the flavor and make the fruit considerably less susceptible to brown core. This is accomplished without much increase in breakdown or shortening of the storage life of the apple. Differences in firmness due to delay in storage, as measured by the Magnus pressure tester, were found to be as follows: 5 days at 65°F., the apples dropped on the average of 3.1 pounds in pressure test, while fruit in cold storage for this period decreased 0.2 pounds; 10 days, the drop was 5 pounds, as opposed to 0.4 pounds for the same period in cold storage.

As in previous years, it was found that McIntosh in common storage softened rapidly and was at its prime for flavor about one month after harvest. Subsequently it rapidly lost its aroma and flavor. When stored at 32°F., softening proceeded more slowly and best flavor was observed between December and March. Stored at 30°F., the McIntosh apples remained high in pressure test and high in acidity, green in ground color, but did not develop prime flavor until February. They remained at their best only for a brief period and even then were not so good as the fruit stored at the other temperatures. Uniformly, throughout the 5-year period of these storage experiments, it has been demonstrated that a temperature of 30°F. not only affects the rate of ripening, but also reduces materially the quantity and quality of aromatic substances finally produced. During this season, there was no significant difference between the lots at 30°F. and 32°F. in occurrence of the brown core disease or of internal breakdown. Fruits stored at the lower temperature have generally been more susceptible to brown core.

Owing to experience in previous years similar to that recorded here, an effort was made this season to determine whether a good flavor developed early in the common storage might be preserved by transferring the fruit to 30°F., and also if, transferring relatively green fruits from the 30°F. room to a higher temperature at early or mid-season date might bring about a desirable flavor during the late winter months. The results, on the whole, were disappointing. Transferring fruit that has reached its prime in common storage to the colder temperature did not seem to prolong appreciably the period at which it is at its best. When transferred from 30°F. to common storage, the apples were of better flavor and appearance during February, March and April, but all of these lots developed extensive brown core trouble.

As in the case of the Baldwin, fruit from different orchards was found to be markedly different in storage quality. That from the Thompson Orchard, about one mile distant from the orchard at the Horticultural Farm, at a lower elevation, and also under sod culture rather than cultivation, was more firm, had a higher acid content and a more yellow ground color. The magnitude of these differences was about equal to those in fruit from the same source by storing in common as opposed to cold storage.

Nearly all storage tests with McIntosh at this institution have been conducted with fruit wrapped in oil paper. This year a series was carried at 32° F. without such wrappers. This variety typically is not subject to scald, and during the present season the unwrapped apples did not differ materially from those wrapped. (*E. J. Rasmussen—Purnell Fund.*)

Variety Tests of Fruit

Thirty trees of the Starking variety, a dark red sport of Delicious, eight years old this season, produced an average crop of one bushel each. The fruit is exceptionally well-colored and, although rather dark, it is not too dark to prove attractive to the buyer. Because this variety colors early it can be harvested from ten days to two weeks earlier than the old red Delicious variety, thus escaping considerable trouble from water core and drop. Even when harvested early, nearly 95% of the fruit grades fancy, whereas half of the standard variety has to be classified as second grade because of lack of color.

The Cortland variety has continued to produce well, demonstrating in particular the characteristics of a good yield at an early age. One of the serious difficulties with this variety is its tendency towards scald in storage, if picked early, and towards breakdown if picked too late. Tests reported under the storage project seem to indicate that by proper management it may be possible to overcome these difficulties.

Fifty trees of Golden Delicious planted in 1923 produced their first large crop in 1933. A very pronounced demand for this variety on the part of consumers *who have been given an opportunity to sample the variety before buying* was noted. A similar experience on a larger scale has been reported by a Massachusetts grower.

Considerable promise is shown by Macoun, a late seedling of the McIntosh produced by pollination with the Jersey Black. It ripens three weeks later than McIntosh, is of a beautiful dark red color, and has an excellent flavor. This variety seems worthy of further tests, and efforts are being made to have fruit growers in various sections of New Hampshire establish trial plantings. Trees in the College Orchard are only eight years of age, and it is not possible yet to judge their productivity.

Two other McIntosh seedlings, Early McIntosh and Milton, which were produced at the N. Y. Experiment Station by cross-pollination with the Yellow Transparent, were tested. The fruit of the Milton ripens about two weeks before the McIntosh, is of excellent appearance and flavor, but does not keep well. There would seem to be a limited market for any variety maturing at this season, when Gravenstein is on the market and McIntosh will be within a few days.

The Early McIntosh resembles its parent McIntosh more closely in form and color than does the Milton, but it is not so good in quality. Since it ripens earlier than the Milton, it may have a place for sale on roadside stands and similar retail outlets.

The Canadian McIntosh seedling, Melba, ripens about the last of July to the first of August. It is of good quality and attractive appearance, although good color develops only during the last few days that the fruit remains on the trees. There is somewhat of a tendency for the fruit to drop before it becomes fully colored.

The Chief raspberry has proved hardier and more resistant to mosaic than the Viking, and is also more productive. Of the newer varieties of strawberries, Dorset is outstanding because of the vigor of the plant, attractive appearance, size of fruit, excellent quality and freedom from disease. Fairfax is also promising in these respects except for slight irregularity of the fruit in form and slight seediness.

Considerable winter injury occurred with most grape varieties belonging to the Labrusca type. The hardier sorts, such as Bacchus and Clinton, were not damaged. In spite of the winter injury, a considerable amount of fruit of excellent quality was produced, especially on the Worden Vines. Green Mountain (Winchell) was severely injured from low winter temperatures and produced little fruit. (*L. P. Latimer, G. F. Potter et al—Hatch Fund.*)

Complete Fertilizer as Opposed to Nitrogen Only in Orchards

Tests of the value of complete fertilizer as opposed to nitrogen only, in New Hampshire orchards, were continued in 1934. As has been reported previously, only very slight differences between the treatments have been found. These are in the direction of lower yield and somewhat better color on the plots fertilized with the complete fertilizers. It seems probable that this is due to a difference in the character of the nitrogen. In the complete fertilizer nitrogen occurs in exactly the same quantity as that applied to the control plot, but it is in a somewhat more slowly available form. Evidence from a variety of sources seems to indicate that phosphorus and potash do not produce an appreciable effect upon apple trees unless they are incorporated deeply in the soil. It seems rather unlikely, therefore, that the presence or absence of these materials is contributing to the results in this experiment. (*G. F. Potter—Hatch Fund.*)

Plant Breeding

Two strains of Des Moines squash coming from the same original source, one of which had been grown since 1928 in South Carolina and the other for the same period in New Hampshire, were not found to differ significantly. Under the same conditions, however, a strain of Australian hull-less popcorn grown for five years in South Carolina proved to be about one week later in maturing than the New Hampshire strain, and at the same time produced ears which were slightly longer and heavier. (*J. R. Hepler — Hatch Fund.*)

Spray Service

The usual pest control service was carried out. This season for the first time in five years the record of codling moths captured in fermented bait traps showed two peaks, the first between July 3 and July 15 and the second between August 17 and August 27. This indicates that a second brood occurred this year, and the fact is corroborated by finding empty pupae skins under some of the bands of untreated corrugated paper. It is rather interesting to note that in certain orchards, woodpeckers drilled through these untreated corrugated bands and removed as many as 80% of the pupating larvae beneath. (*E. J. Rasmussen—State Fund.*)

Foot Rot of Peas

To study variation in infection of the seed with foot rot, 72 different varieties and strains of peas were grown in pure sand in a greenhouse bench, supplying nutrients from a culture solution. From 4.2% to 93% of the plants in the several lots were found to be diseased. The average was about 45%. The varieties Laxton's Progress and Little Marvel were also grown in an infected soil in a garden where peas yield only 10 to 20% of a crop on account of foot rot. In the infected soil, germination on the average was about 10 to 20% lower, and of the plants formed, an additional 15 to 20% were affected with the disease. Disinfection of the seeds with red copper oxide, with Semesan Jr. and Trioxo was tried, but did not give any clearcut advantage. (*J. R. Hepler—Miscellaneous Income.*)

Peat vs. Manure

The experiment of fertilizing the soil in greenhouse ground beds for tomatoes, using about 200 pounds of peat on a plot 18x25 feet, compared to a half load of manure on the same area, reached its third season. The tomatoes were planted at such a time that the crop would be harvested during the early spring months. One hundred forty plants under the manure treatment yielded 1,552 pounds of fruit, as opposed to 1,443 from the same number of plants on the plot fertilized with peat. This is the largest difference between the treatments which has appeared to date. (*J. R. Hepler—Miscellaneous Income.*)

Breeding Studies

The third experiment in a series with epidemic tremors tends to prove, as did the previous ones, that it is doubtful if the condition is either inherited or transmitted by way of the egg.

In previous experiments attempts to produce the disease by continued breedings and hatchings with diseased birds or with direct filial descendants failed. In Experiment No. 3, various crosses from the above groups were made. The chicks from these crosses were confined in an electrically heated battery brooder for a period of four weeks.

At no time during the experimental period did any of the chicks exhibit symptoms of epidemic tremors. From a total of 131 chicks on the test only two deaths occurred, and neither of these was attributed to the disease upon autopsy.

The weight of the experimental groups, though slightly less than the check group, showed growth very close to normal. (*A. E. Tepper, F. D. Reed, and T. B. Charles—Purnell Fund.*)

Inoculations—Epidemic Tremors

A filtrate made from a solution of the brain and spinal cord tissue of chicks affected by epidemic tremors was injected into the cranial cavity of suspectible chicks, in different amounts. The chicks were observed for a period and those which survived the mechanical operation showed no evidence of tremors. (*C. L. Martin, C. A. Bottorff, and L. W. Slanetz—Purnell Fund.*)

Protein Level Requirements for Growing Chicks

Protein levels higher than 22% and lower than 18% give poor growth, and a level of 16% protein produced better results than a level of 24% or over, according to a study made with nine groups each of fifty S.C.W. Leghorns.

Other important facts gleaned from this study were that high protein levels produce fair growth for six weeks, and that growth after six weeks is decidedly inferior. Protein requirements of S.C.W. Leghorns appear to be quite similar to the requirements for New Hampshire Reds. (*A. E. Tepper, F. D. Reed, and T. B. Charles—Purnell Fund.*)

Vitamin A Requirements for Growing Chicks

With a ration deficient in Vitamin A, very little difference in weight gains was shown between levels of 1%, 2% and 3% cod liver oil. It was found in a feed consumption and weight record analysis that the level of 1% is most efficient and economical for growing chicks.

These experiments were carried out with nine groups of 50 New Hampshire Red Chicks each, or 450 chicks. The test groups were fed varying quantities of cod liver oil added to a basal ration deficient in Vitamin A. In addition to the cod liver oil groups, one group was fed ½% sardine oil plus the basal ration.

All groups receiving varying quantities of cod liver oil or sardine oil in basal ration were subjected to daily irradiation from an ultra-violet ray lamp to furnish a supply of Vitamin D above their normal requirements. The group receiving basal ration plus ½% sardine oil showed slightly less weight gain than did the cod liver oil fed groups. At no time during the course of the experiment were there any symptoms of a Vitamin A deficiency. (*A. E. Tepper and F. D. Reed—Purnell Fund.*)

Sardine Oil vs. Cod Liver Oil

Sardine oil used at ½% level in tests to determine its relative merits in competition with cod liver oil in the New England College Conference Ration proved equally efficient to 1% cod liver oil under the conditions of the experiment. Since the market price of sardine oil has been 25% less than cod liver oil, a worthwhile saving should be possible through its use.

Three groups of New Hampshire Red Chicks, two of the groups comprising 50 chicks and one group 100, were fed the New England College Conference ration plus the substitution of ¼% sardine oil in Group 1, ½% sardine oil in Group 2, and the regularly recommended 1% cod liver oil in Group 3.

The groups were carefully segregated and weighed before the experiment started. The ½% sardine fed group and the 1% cod liver oil fed group weighed about the same as the experiment progressed. The ¼% sardine oil fed group was approximately .2 of a pound lower.

There was a difference in feed consumption in favor of both the sardine fed groups. (*A. E. Tepper—Purnell Fund.*)

Control of Coccidiosis

Experiments with birds immunized from coccidiosis by an injection of E. Tenella, the acute type, indicated that this vaccine does not immunize the birds from E. Necatrix, one of the so called chronic types of coccidia.

It was found further that keeping the litter dry is at least as effective as commercial mixtures for treating litter. (*C. L. Martin, C. A. Bottorff, and T. B. Charles—Purnell Fund.*)

Poultry Autopsies

During the past fiscal year there were performed at the Poultry Pathology Laboratory 2,816 poultry autopsies; 1,533 of these were adult chickens, 1,168 were chicks, and 115 were miscellaneous specimens, consisting of turkeys, pheasants, bantams, quails, pigeons and partridges.

The principal diseases of the adult group were: ruptured egg yolk 57%; coccidiosis 16%; nephritis (inflammation of kidneys) 14%; pneumonia 13%; indigestion 10%; tumors 6.7%; and round worms 5.8%.

The principal diseases of the chicks were: pneumonia 49%; coccidiosis 12%; pullorum disease 10.1%; indigestion 8.7%; and navel infection 7.6%.

An inspection of all birds dying on ten poultry farms under the adult mortality project represents about two thirds of the adult chicken autopsies and one third of the chick autopsies of this report. (*C. L. Martin and C. A. Bottorff—Miscellaneous Income.*)

Adult Mortality

Of the 1,042 adult birds examined, ruptured egg yolk condition was the main offender with 43%, followed by pneumonia with 16.17%, nephritis 15.8%, indigestion 7.3%, and coccidiosis 7.2%. Of the 355 chicks examined under this project pneumonia was first with 74.3%, followed by indigestion, 24.7%; navel infection 14.7%; and coccidiosis 6.7%. (*C. L. Martin and C. A. Bottorff—State Fund.*)

Ruptured Egg Yolk in Domestic Fowl

There were about 30 birds with ruptured egg yolk condition studied this year. Cultures were made from the heart, lungs, liver spleen, kidneys, ova, yolk material and peritoneal fluid. Ten different species of bacteria were isolated.

Representative strains of these bacteria which showed possible significance to ruptured egg yolk were injected into the peritoneal cavity of healthy laying birds. Their physical condition did not change to any marked degree. Two did, however, stop laying. A second intraperitoneal inoculation was made two weeks after the first and some of the birds became droopy, but recovered in two days. Autopsies showed that none of the cultures injected produced the ruptured egg yolk condition. Two of the species of organisms did produce peritonitis.

An attempt has also been made to determine if an active, living causative agent is present in the ruptured egg yolk material taken from birds which have died from this trouble. This material has been injected into the peritoneal cavity of healthy laying birds. No evidences of infection was noted.

Losses from ruptured egg yolk have been greatly diminished by more careful handling of the birds and by making perches and laying nests more easily accessible. (*C. L. Martin, C. A. Bottorff, and L. W. Slanetz—Purnell Fund.*)

Control and Vaccination—Infectious Laryngotracheitis

Infectious Laryngotracheitis epidemic started in New Hampshire in March, 1934. By June it had spread to five farms in the State involving over 75,000 birds. As soon as the disease was discovered, the flocks were vaccinated with an autogenous vaccine prepared from the affected birds. The mortality varied from 5% to 15% as compared to 50% in cases where no vaccination was practiced.

Due to these five outbreaks, flocks in the immediate vicinity were vaccinated as a precaution.

There were eleven farms that vaccinated approximately 31,000 birds as a preventative. In all cases there was a good take and no adverse results were noted from the vaccination. (*C. A. Bottorff and C. L. Martin—State Fund.*)

Testing for Bang's Abortion Disease

The greater amount of testing for Bang's Abortion Disease by the standard tube agglutination blood test was made from blood sent in by practicing veterinarians. There were 3,346 samples tested from herds in New Hampshire, as compared to 2,615 samples last year. The percentage of infection this year was 8.9% as compared to 14.41% last year. This is probably due to retests of many herds where the reactors had been removed since the previous year.

Out of state samples tested, numbered 1,210 as against 835 the previous year, These showed an infection of 18%.

At the present time Federal testing is being carried on whereby an indemnity is being paid for slaughtered reactors at a maximum of $20 per head for grade cattle and $50 per head for purebreds. The work was started in October and this laboratory is recognized as the official testing laboratory for New Hampshire.

By replacing reactors to Bang's Abortion Disease tests with heifers which have been raised free from the disease, five or six herds which have been studied have shown a constant decrease in infected members. The sixth group, where no isolation of reactors was practiced, has shown an infection increase from 7 positives, 3 suspicious and 6 negatives to 10 positives, 1 suspicious, and 4 negatives. During this time many reactors have been removed, but the wave of infection continued.

The project will be continued to determine how long it will take to eliminate all reactors from these herds, by practicing this method of testing along with proper isolation and segregation. A check will also be made to determine how long clean herds will remain clean under practical conditions. (*C. L. Martin—Purnell Fund.*)

Pullorum Testing

During the past fiscal year 209,754 samples from 206,443 birds were tested for Pullorum. There were 29,643 fewer samples than for the previous season, but only 5,920 fewer birds tested because of less retesting. The total number of adult birds tested is still more than one fifth of the total number of adult birds in the State of New Hampshire, and of these birds tested 99.83% were found to be free from Pullorum.

There were 146 flocks containing 175,650 birds that had been tested 100% for two or more consecutive years and no reactors found. There were 25 flocks containing 10,926 birds that were tested 100% for the first time and no reactors found. There were 22 flocks in which only part of the total birds were tested and all of the 10,472 birds tested were negative.

There were 10 flocks of the 203 flocks tested in which infection was found, as compared to 23 infected flocks the previous season.

Of the flocks in which infection was found, 4 flocks had been tested 100% for two or more consecutive years and of these flocks two were Pullorum Accredited (two or more 100% tests—no reactors) and two were Pullorum Free (one 100% test—no reactors). Of the formerly Pullorum Accredited flocks .8 of 1% of the 1,901 birds tested were reactors. There were .07 of 1% reactors of the 3,866 birds tested in the two formerly Pullorum Free flocks.

Five flocks testing all birds for the first time showed 12.8% of the 2,582 birds as reactors. One flock testing only part of the flock had 1.6% of the 298 birds which were reactors. There were no reactors found in the 14,643 males tested. (*C. A. Bottorff and C. L. Martin—Miscellaneous Income.*)

Record of Performance Report

New Hampshire poultrymen, in spite of troubled times, have shown a decided interest in better breeding, and more trapnesting and pedigree work is being done than ever. Record of performance work, which is merely officially supervised trapnesting and breeding, has kept pace with this trend. Through the medium of eight annual inspections by a representative of the Experiment Station the breeder secures official recognition of his records.

Developments in Record of Performance this season include an increase in membership to nine breeders (1 of Barred Rocks; 1 of White Rocks; and 7 of New Hampshire Reds). A major change in rules has been made to give recognition to the breeding value of individual birds, taking into consideration the performance of the progeny of an individual mating. Minor changes in rules, involving egg weights and body weights, have also been made.

Results of the third season of Performance show 1,608 birds entered in the project, 272 meeting the requirements for R.O.P. Certificates (200 eggs or over, 24 oz. in size); 106 birds winning advance certificates (240 eggs or over, 24 oz. in size). A total of 378, or 23.5%. This shows progress over previous seasons' averages of 22.12% for 1931-32, and 23.4% for 1932-33. (*F. D. Reed—Miscellaneous Income.*)

Certification of Poultry

There were 16,066 birds handled for certification during the period July 1, 1933 to July 1, 1934. Certification work entails the handling of a flock by a member of the Experiment Station staff and grading the birds into classes of breeders, layers and culls.

Due to changes in the terminology of the poultry Hatchery Code, the work will be known in the future as "Approval" rather than "Certification." (*F. D. Reed—Miscellaneouse Income.*)

Distribution of Fowl Pox Vaccine

The Poultry Pathology Laboratory distributed a total of 274,800 doses of fowl pox vaccine during the fiscal year. New Hampshire poultrymen used 254,200 doses, an increase of 62,650 doses over the previous season.

Inspection Service

Feedingstuffs Inspection. In the enforcement of the law regulating the sale of concentrated commercial feedingstuffs, 386 brands were analyzed for the State Department of Agriculture. The analyses required about 2,900 individual determinations.

Fertilizer Inspection. In the enforcement of the law regulating the sale of commercial fertilizers, 109 brands were analyzed for the State Department of Agriculture. These analyses required about 720 determinations.

Soil Tests. Various methods for the determination of available plant nutrients in soils have been tested by applying them to the soils from the field experiments, whose treatment and response to fertilizers are known. It is now possible to learn more about a soil sample than ever before, and to give more definite recommendations as to fertilizer treatment and soil management. This service was available about March 1st, 1934. During the previous eight months of the fiscal year about 150 samples of soil had been received and tested for acidity. From March 1st to July 1st, 1934, over 250 samples were received and over 2,200 individual determinations were made on them.

Some 35 samples of peats, leaf molds, feeds, fertilizers and other materials, sent in by residents of the State, have been examined. This work has required about 100 individual determinations. Numerous inquiries not involving analyses have been received and answered.

Seed Certification. In 1933 there were 79 acres of Green Mountain potatoes entered for certification and 4 acres of Triumphs, mostly the white variety. All the fields entered passed certification.

Seed Inspection. The regular seed inspection work for the State Department of Agriculture was conducted as usual. During the period from July 1, 1933 to June 30, 1934, the laboratory handled 461 samples, of which 412 were collected by the state inspector and are reported in Bulletin 282. The remaining 49 samples were sent in by private individuals. (*Betty G. Sanborn and L. J. Higgins—Miscellaneous Income.*)

Pneumatic Tractor Tires

The experiments with pneumatic tires for tractors consist of testing two sets of nationally known make in actual farm operations on the college and horicultural farms, with the object to determining the wearing qualities, upkeep and repair costs, and tractive ability on New Hampshire soils and grades.

Results thus far obtained indicate an exceedingly low rate of wear or abrasion from farm usage, assuring a long life. Accidental injury to the casings now appears to be the important consideration and only two occasions of this kind have occurred in 19 months. Small front tires are subject to greater amount of such injury than large rear tires, apparently. Chains, lugs, and similar devices are being experimented with to provide additional traction in wet going. (*W. T. Ackerman and G. M. Foulkrod—Purnell.*)

Electric Brooding of Chicks

The brooding of chicks by electricity in unheated colony brooder houses was successfully carried out through the winter and spring of 1933-1934.

One of the coldest winters on record was experienced, the temperature going as low as 30° below zero. For several days at a time the average for a 24-hour period was approximately zero. Notwithstanding this extreme temperature, the losses were moderate and due to causes which might occur under any practical method of brooding.

The growth of chicks was very favorable, uniformity was well in evidence, and feathering was somewhat more rapid than similar lots under hot-water brooding.

Comparisons between chicks in insulated and non-insulated houses as to feed consumption, weight gains, condition of chicks, condition of litter and kilowatt-hours consumed showed practically no difference. The use of insulation on walls and ceiling, therefore, seems to be unwarranted.

The average current consumption for the entire brooding period was 1.55 kwhs. in insulated houses and 1.65 kwhs. in uninsulated houses.

It was found that during extremely cold weather the litter just outside the edge of the hover became so damp, due to the condensation of moisture carried in the warm air, that frequent removal was necessary.

There is not sufficient heat loss from the electric brooder to evaporate moisture so deposited. (*W. T. Ackerman, T. B. Charles, G. M. Foulkrod, A. E. Tepper, and F. D. Reed—Purnell Fund.*)

Part-Time Farming Study

The part-time farming project was carried on as a Civil Works project at the request of the Division of Subsistence Homesteads, U. S. Department of the Interior. Of the 724 farms studied, only 66 reported that sales of products exceeded the cost of food purchased. The average sales of farm products amounted to $84; the average value of products raised, $203. (*CWA Funds.*)

Rural Housing and Electrification

The rural housing survey was started in January and completed in March as a Civil Works project. There were three men and from 13 to 19 women working on this project during that time. Living conditions in 2,040 farm homes in Merrimack County were studied. The typical farm house was found to be 50 years old and badly in need of paint; the greatest need is a living room and closet space; it has the kitchen sink piped with cold water; one in four has a bathtub; half have electricity and refrigeration; wood or coal are used for cooking; the laundry and kitchen are the same room.

A sub-project of the rural housing survey, called the farm house planning project, employed two draftsmen for two-and-one-half months in the drawing up of plans for the electrical layout for a modernized farm kitchen, methods of repairing and rebuilding of chimney and flues to reduce fire hazards, and plans and details for sun-room and vegetable storage cellars which might be added to present farm houses. (*C.W.A. Funds.*)

Publications

Station publications issued during the year were as follows:

Station Bulletins 273—Roughage Production in New Hampshire
" " 274—Pollination and Fruit Setting in the Apple
" " 275—Efficiency Studies in Dairy Farming
" " 276—Results of Seed Tests 1933
" " 277—Inspection of Commercial Feeding Stuffs 1933
" " 278—Inspection of Commercial Fertilizers 1933
" " 279—Studies in Economics of Apple Orcharding
Part II. A Study of Farm Organization on 12 Fruit Farms
" " 280—Agricultural Research in New Hampshire 1933
Technical " 56—Burgundy Mixture
" " 57—The Significance of Colon Organisms in Raw Milk
" " 58—1. Methods of Expressing Toxicity; 2. Toxicity of Nicotine, Hyptylic Acid and Caproic Acid to Mosquito Larvae, *Culex pipiens* L.
" " 59—The Effect of Potassium Deficiency on the Composition of the Tomato Plant
" " 60—1. A Technique for Tracing Penetration of Petroleum Oil in Insect Eggs. 2. Some Determinations of Oil Penetration in Insect Eggs. Contact Insecticides VIII
Station Circular 44—Liming New Hampshire Farms
" " 45—How Often Should the Potato Grower Renew His Stock?
" " 46—Electric Brooding of Chicks. 1. Heat Requirements
Scientific Contribution 43—The Relation of Weather to Pollination of the McIntosh Apple
" " 44—A Two-year Study of Labor and Equipment Used in Spraying Forty-two New Hampshire Orchards

FINANCIAL STATEMENT

Expenditures of the New Hampshire Agricultural Experiment Station for the Year Ending June 30, 1934

	Hatch Fund	*Adams Fund*	*Purnell Fund*	*Supplementary**	*Total*
Personal services	$10,142.77	$12,976.43	$48,756.47	$20,299.37	$92,175.04
Supplies and materials	713.14	882.91	3,116.33	3,925.50	8,637.88
Communication service	1,055.02	.30	66.09	319.03	1,440.44
Travel expenses	316.30	72.93	3,196.00	4,864.17	8,449.40
Transportation of things	316.08	18.37	239.83	147.94	722.22
Printing and illustrating publications	779.91	.....	508.11	98.83	1,386.85
Heat, light, water, and power	706.34	.96	29.90	22.28	759.48
Contingent expenses	23.38	22.00	50.81	645.06	741.25
Equipment	923.06	747.38	3,345.05	1,290.30	6,305.79
Buildings and land	24.00	278.72	691.41	1,055.92	2,050.05
Balance	None	None	None	15,225.63	15,225.63
Totals	$15,000.00	$15,000.00	$60,000.00	$47,894.03	$137,894.03

*This fund includes expenditures from the following sources:

State appropriations	$7,076.37
Sales and miscellaneous income	40,817.66
	$47,894.03

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